SELECTED ARTICLE

THE PREPARATION OF CITRUS FRUIT JUICES*

THE following statement has been prepared in response to specific inquiries received at the Imperial Institute and may be of interest to others in the Empire who are considering starting an industry in these products. The Institute will be pleased to furnish inquirers with further particulars regarding details of the processes and the names of firms which supply the necessary equipment.

Citrus fruit juices come on to the market in various forms, as (*a*) cordials, (*b*) squashes, (*c*) pure fruit juices, with or without fruit cells, (*d*) juices for special purposes, such as concentrates for use in the milk bar trade, &c.

Cordials are clear beverages consisting of fruit juice to which has been added syrup, usually together with small quantities of flavouring and colouring materials. Squashes differ from cordials in that they are cloudy, due to the presence of fruit cells and suspended matter in the juice used in their preparation. The proportion of fruit juice in these beverages varies somewhat according to the particular brand, but it may be regarded usually as forming from about a third to a half of the whole. Both cordials and squashes are also prepared in an aerated or carbonated form.

Early in the development of the citrus fruit juice industry all citrus juices were rendered clear, but the trend to-day, with the exception of lime juice, is towards a cloudy or pulpy juice.

During recent years a great deal of work has been done, particularly in the United States, in devising methods of preserving citrus juices in their natural state without the addition of preservatives or other materials. In America large quantities of citrus juices are consumed in this form, but so far as the United Kingdom is concerned cordials and squashes are still the popular types of beverages.

The juices of the different citrus fruits vary in keeping properties and the methods of manufacture vary somewhat accordingly.

Lime juice manufacture, for instance, presents comparatively little difficulty. The whole fruit is crushed between rollers which express the juice together with the essential oil from the peel. The oil is then separated by centrifuging. The juice is allowed to settle and the clear liquid drawn off, preservative in the form of sodium or potassium metabisulphite added and the juice packed in casks.

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The extraction of the juice from the other important citrus fruits such as orange, lemon and grapefruit is carried out briefly in the following manner: in the most commonly used method the whole fruit after washing is cut in half at right angles to the axis of growth and the juice extracted by pressing the halved fruit against a revolving conical ribbed or grooved extractor or burrer. By adjusting the speed of the burrer, it can be so arranged that the inclusion in the juice of any considerable amount of " rag " or pith and essential oil from the peel can be avoided. The large pieces of fruit particles and seeds are then removed by screening, leaving behind only the finer fruit cells. When required for the manufacture of squash the juice is shipped in this form in casks with the addition of preservative.

According to the Food and Drugs Act sulphur dioxide and benzoic acid are the only preservatives permitted in non-alcoholic beverages sold in the United Kingdom. The product when retailed to the consumer must not contain more than 350 parts per million of sulphur dioxide or 600 parts per million of benzoic acid. The preservative is usually added in the form of solutions of sodium or potassium bisulphite and sodium benzoate respectively. The equivalent amounts of these three compounds are approximately 570 parts per million of sodium bisulphite, 650 parts per million of potassium bisulphite and 710 parts per million of sodium benzoate.

Benzoic acid often imparts an unpleasant " burning " taste to fruit juices and the use of sulphur dioxide preservatives is generally preferred. Raw fruit juices when imported into the United Kingdom normally contain approximately the following amounts of sulphur dioxide per million:

Lemon and lime juice	350 parts.
Grapefruit juice	650–750 parts
Orange juice	750–850 parts

As the juices are usually diluted two to three times in making up beverages, the content of sulphur dioxide in the final product is well below the permissible amount. Further preservative is then often added to bring the content up to 350 parts per million.

In the case of orange juice a certain amount is prepared in the concentrated form in order to save bulk in shipment. For this purpose the juice is roughly filtered before concentration and concentration is carried out under reduced pressure in special plant.

As already mentioned, the demand in the United Kingdom is for cloudy citrus fruit juices. The removal of suspended matter, though in some cases improving appearance often detracts considerably from the colour, flavour and nutritive value of the expressed juice. The colour and flavour of orange juice depends to a large extent on the suspended particulars which it contains and the removal of these gives a straw-yellow product lacking aroma and flavour. Orange juice is therefore now seldom prepared in the clear form.

The efforts in the United States to market citrus juices in a form closely resembling the natural juice has involved additional stages in their preparation. The modern method of manufacturing citrus juices which is carried out extensively in the United States proceeds along the following general lines. After

the screening of the juice to eliminate the seeds and coarse pulp, it is subjected to a process of de-aeration, *i.e.*, the removal of the occluded air in the juice by means of vacuum treatment. It has been found that the presence of air in the juice markedly affects the flavour after storage, particularly if the juice has to be submitted to heat treatment. De-aeration is accomplished by passing the juice in the form of a fine spray into an evacuated tank. This removes any air which has been occluded in the juice and in the fruit particles. After the tank is partly filled the juice is held under a vacuum of at least 27 in. for about 10 minutes. The vacuum may then be relieved, preferably with an inert gas such as nitrogen.

Immediately after de-aeration the juice is passed to a flash pasteuriser. Usually the de-aerating unit is connected with the pasteurising unit so that the juice does not come in contact with air until issues hot from the pasteuriser. Flash pasteurisation consists of subjecting the juice to a high temperature, in the neighbourhood of 200°F., for a very short period, sometimes only a few seconds. In ordinary pasteurisation, of course, the juice is heated at a lower temperature for some time. After flash pasteurisation the juice is packed either in cans or bottles under vacuum. Grapefruit juice has better keeping properties than either orange or lemon.

If a clear juice is required the method most generally applicable depends on the fact that by heating the juice the colloidal matter is coagulated and will then settle out readily and can be removed by filtration. The de-aerated juice is passed through a flash pasteuriser and held at about 180°F., for about a minute, cooled rapidly, a quantity of filter aid, such as kieselguhr, added, and the whole passed through a filter press. Such a process gives a fairly good product, but as already pointed out it is inferior to the juice in which the fruit cells are allowed to remain. Another method used for preparing clear juices is clarification by the gelatin-tannin process.

The following account of the gelatin-tannin process is given in *Circ.* 344, *Agricultural Experiment Station, California* :

" The bulk of the suspended matter, particularly in apple juice, consists of protein and pectin-like substances. These colloidal substances carry an electrical charge, generally negative, and are precipitated when this charge is reduced to zero by the addition of a colloid bearing an electric charge opposite in sign to that of the colloid to be removed. Gelatin and casein act in part in this manner and in part by forming insoluble precipitates with the constituents of the juice (casein with acid, gelatin with tannin) which on settling carry with them other suspended particles.

" The gelatin-tannin process is the most widely used colloid-precipitation process for clearing fruit juices, but since the chemical reaction involved must be accurately adjusted for each juice and each type of gelatin used, considerable time and experience are necessary in making the required tests. Laboratory tests are first conducted to determine the correct amount of gelatin to add for the juice to be treated. Since there is danger of clouding the juice by the use of too much gelatin, tannin is usually added so that no excess of gelatin remains. The addition of tannin to the juice also helps to minimize the bleaching of the colour that occurs during a gelatin-tannin clarification, since the

added tannin helps to replace the natural tannins of the juice removed during clarification. In commercial practice about 1·25 oz. of tannin and from 1·5 to 6·0 oz. of gelatin, according to the condition of the juice, are required per 100 galls. The tannin is added first to the juice, the juice being well stirred, next the gelatin solution, the juice being agitated during and for several minutes after the addition of the gelatin solution. After this the treated juice is allowed to stand undisturbed for 18 to 24 hours for the precipitated matter to clot together and settle out. The clarified juice is then siphoned off the sediment, care being taken not to disturb the latter."

Another widely used process of clarification, particularly for apple juice, is by the use if pectin-destroying enzymes. These transform pectin into insoluble pectic acid which on precipitation carries down other suspended matter. There are various enzyme preparations on the market, and the manufacturer's directions should be closely followed if the best results are to be obtained. The amount to be used will depend on the type and activity of the enzyme, the amount of suspended matter in the juice, the composition, particularly the acidity, of the juice and the temperature and time of storage. After clarification by enzymes the juice must be heated to 150°F. to prevent any further enzyme action.

As citrus juices contain considerably less colloidal and pectinous material than apple or grape juice for instance, methods of clarification such as those mentioned above are sometimes omitted, and the clear juice prepared simply by centrifuging to remove the bulk of solid material, and then filtered through pulp filter after the addition of a filter aid.

In the older methods the extracted juice was allowed to defecate, that is it was allowed to stand until the solid matter settled out in a layer at the bottom of the container. Preservative such as potassium metabisulphite was added to prevent fermentation during the process. After the juice had defecated a sufficient length of time it was passed through a pulp filter, filter aids being sometimes used. The clear juice was then pasteurised in bottles or casks. Although with citrus juices prepared by this method there is very little settling out on storage, the quality and appearance bears no comparison with juices prepared by up-to-date methods.

The type of juice to be manufactured will depend entirely on the market to be supplied. If a fastidious taste is to be met and one which demands a juice closely approximating to the fresh natural product then every precaution must be introduced into the method, resulting in higher costs of plant and manufacture. If, however, a fruit juice cordial making no pretence at approaching the nature of the fresh juice, is required then extraction, followed by filtering and addition of syrup, flavouring and colouring materials, and preservatives will probably suffice.

Literature.—Further details of the methods of fruit juice extraction, preservation and the manufacture of beverages are given in the following publications:

Commercial Fruit and Vegetable Products.—By W. V. Cruess. 1938. Obtainable from the McGraw-Hill Publishing Co., Ltd., Aldwych, London, W.C. 2, price 36*s*.

Fruit and Vegetable Juices.—By D. K. Tressler, M. A. Joslyn and G. L. Marsh, 1939. Obtainable from the Avi Publishing Co., Inc., 31, Union Square, New York, price $6·15 post free.

"Utilization of Fruit in Commercial Production of Fruit Juices." By M. A. Joslyn and G. L. Marsh. *Circular* 344 (1937), *California Agricultural Experiment Station.* Obtainable from the University of California, Berkeley, California, U.S.A., price not stated. An excellent account of modern practice.

"The Preservation of Citrus Fruit Juices." By H. A. Tempany. *Bulletin of the Imperial Institute,* 1938, 36, No. 3, 334–349.

"Retaining Flavour and Vitamin Content in Fruit juices." By M. A. Joslyn. *Fruit Products Journal,* 1937, 16, No. 8, 234–336.

"Some Observations on the Preparation and Preservation of Citrus Fruit Squashes." By Lal Singh and Girdhari Lal. *Indian Journal of Agricultural Science,* 1938, 8 Pt. I., 77–91. Obtained from the Manager of Publications, Delhi, price 5*s.* 3*d.*

Beverage Manufacture (Non-Alcoholic).—By R. H. Morgan, 1938. Obtainable from Attwood & Co., Ltd., St. Ann's Chambers, Waithman Street, London, E.C. 4, price 30*s.* This book does not deal with the actual extraction of the juice, but with its use in beverage manufacture.

"Citrus Products," Parts I and II. By J. B. McNair. Issued as *Publication* No. 238 (1926) and *Publication* No. 245 (1927), *Chicago Field Museum of Natural History.* Obtainable from the Museum, price not stated. Although dealing with the older methods, these volumes contain much useful general information.